PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
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ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing: 04 May 2000 (04.05.00)	
International application No.: PCT/JP99/05838	Applicant's or agent's file reference: PEB187
International filing date: 22 October 1999 (22.10.99)	Priority date: 23 October 1998 (23.10.98)
Applicant: NAGASAKA, Hiroshi et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International preliminary Examining Authority on:

28 February 2000 (28.02.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

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Facsimile No.: (41-22) 740.14.35

Authorized officer:

J. Zahra

Telephone No.: (41-22) 338.83.38

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INTERNATIONAL SEARCH REPORT

Inter ...nal Application No
PCT/JP 99/05838

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C23C14/06 C23C14/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C23C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MUENZ W -D: "TITANIUM ALUMINIUM NITRIDE FILMS: A NEW ALTERNATIVE TO TIN COATINGS" JOURNAL OF VACUUM SCIENCE AND TECHNOLOGY: PART A,US,AMERICAN INSTITUTE OF PHYSICS. NEW YORK, vol. 4, no. 6, November 1986 (1986-11), page 2717-2725 XP002064735 ISSN: 0734-2101	1,4
Y	paragraphs '0002!,'0003!; table 1	2

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 January 2000	02/02/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Ekhult, H

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INTERNATIONAL SEARCH REPORT

Inter ...nal Application No
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X	SUN X ET AL: "REACTIVELY SPUTTERED TI-SI-N FILMS 1. PHYSICAL PROPERTIES" JOURNAL OF APPLIED PHYSICS,US,AMERICAN INSTITUTE OF PHYSICS. NEW YORK, vol. 81, no. 2, 15 January 1997 (1997-01-15), page 656-663 XP000659450 ISSN: 0021-8979 paragraph '0003! ---	3
X	EP 0 166 349 A (SUMITOMO ELECTRIC INDUSTRIES) 2 January 1986 (1986-01-02) claims 1-4 ---	5
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Y	SHEW B -Y ET AL: "Effects of r.f. bias and nitrogen flow rates on the reactive sputtering of TiAlN films" THIN SOLID FILMS,CH,ELSEVIER-SEQUOIA S.A. LAUSANNE, vol. 293, no. 1-2, 1997, page 212-219 XP004080859 ISSN: 0040-6090 paragraph '03.3! --- -/--	2

INTERNATIONAL SEARCH REPORT

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A	EP 0 685 439 A (EBARA CORP ;AGENCY IND SCIENCE TECHN (JP)) 6 December 1995 (1995-12-06) claims 1-3	6-9
A	US 5 731 079 A (EVANS JOSEPH D ET AL) 24 March 1998 (1998-03-24) column 3, line 12 - line 28	9

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inten nal Application No
PCT/JP 99/05838

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0166349 A	02-01-1986	JP 1760725 C	20-05-1993
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US 5731079 A	24-03-1998	US 5681653 A	28-10-1997

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(11) International Publication Number: **WO 00/24947**

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10/302259 23 October 1998 (23.10.98) JP
10/302260 23 October 1998 (23.10.98) JP

(71) Applicant *(for all designated States except US)*: EBARA CORPORATION [JP/JP]; 11–1, Haneda Asahi–cho, Ohta–ku, Tokyo 144–8510 (JP).

(72) Inventors; and

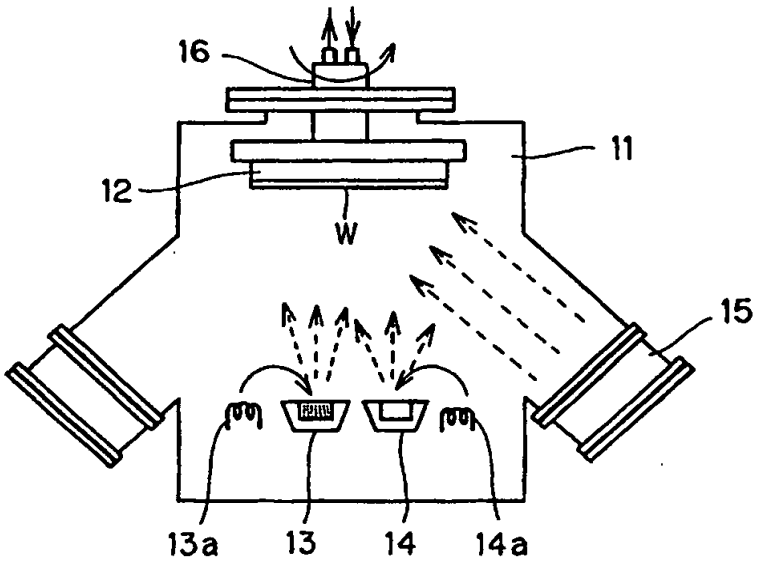
(75) Inventors/Applicants *(for US only)*: NAGASAKA, Hiroshi [JP/JP]; Ebara Research Co., Ltd., 2–1, Honfujisawa 4–chome, Fujisawa–shi, Kanagawa 251–8502 (JP). KAKUTANI, Momoko [JP/JP]; Ebara Research Co., Ltd., 2–1, Honfujisawa 4–chome, Fujisawa–shi, Kanagawa 251–8502 (JP). MIYASAKA, Matsuho [JP/JP]; Ebara Research Co., Ltd., 2–1, Honfujisawa 4–chome, Fujisawa–shi, Kanagawa 251–8502 (JP). KATAOKA, Tadashi [JP/JP]; Ebara Corporation, 11–1, Haneda Asahi–cho, Ohta–ku, Tokyo 144–8510 (JP).

(74) Agents: WATANABE, Isamu et al.; Gowa Nishi–Shinjuku, 4th floor, 5–8, Nishi–Shinjuku 7–chome, Shinjuku–ku, Tokyo 160–0023 (JP).

(81) Designated States: CN, KR, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: SLIDING MEMBER AND MANUFACTURING METHOD THEREFOR



(57) Abstract

This invention relates to a hard coating developed for applications involving high–temperature corrosion by improving the performance of TiN coatings while retaining the superior wear resistance and low friction coefficient of TiN itself. The nitride–based sliding material has a face–centered cubic crystalline structure with lattice constant of between 0.414 and 0.423 nm, and is made of mostly TiN but contains at least one element selected from the group containing Al, Cr, Zr and Hf; or comprises a nitride–based material containing substantially titanium nitride and at least one element selected from a group consisting of B and Si, and having a face–centered cubic crystalline structure comprising crystallites of an average size of not more than 9 nm.

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INTERNATIONAL SEARCH REPORT

Inter ›nal Application No
PCT/JP 99/05838

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C23C14/06 C23C14/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C23C

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Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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Y	paragraphs '0002!,'0003!; table 1	2
	-/--	

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Date of the actual completion of the international search	Date of mailing of the International search report
26 January 2000	02/02/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Ekhult, H

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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X	EP 0 166 349 A (SUMITOMO ELECTRIC INDUSTRIES) 2 January 1986 (1986-01-02) claims 1-4 ---	5
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INTERNATIONAL SEARCH REPORT

Inter ›nal Application No
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		JP 9068227 A	11-03-1997
		JP 9068228 A	11-03-1996
		US 5700546 A	23-12-1997
US 5731079 A	24-03-1998	US 5681653 A	28-10-1997

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REPLACED BY ART 34 AMDT

CLAIMS

1. A sliding member comprising a substrate and a hard coating formed on said substrate, wherein said hard coating comprises a nitride-based material containing substantially titanium nitride and at least one element selected from the group consisting of Al, Cr, Zr and Hf, and having a face-centered cubic crystalline structure with a lattice constant ranging from 0.414 to 0.423 nm in a crystal of said nitride-based material.

2. A sliding member according to claim 1, wherein said crystal has crystal orientation in (111) planes.

3. A sliding member comprising a substrate and a hard coating formed on said substrate, wherein said hard coating substantially comprises a nitride-based material containing substantially titanium nitride and at least one element selected from a group consisting of B and Si, and having a face-centered cubic crystalline structure comprising crystallites of an average size of not more than 9 nm.

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4. A sliding member according to any of claims 1 to 3, wherein said nitride-based material has a chemical composition defined in a formula, excepting inevitable impurities:

$Ti_{(100-x)}Me_x$ nitride compound

where Me represents one element selected from the group consisting of Al, Cr, Zr, Hf, B and Si, and x is in a range given by a relation:

2 atomic % $\leqq$ x $\leqq$ 30 atomic %.

5. A method for making a sliding member according to any of claims 1 to 4, comprising the steps of: forming a hard coating on said substrate by simultaneously depositing in a vacuum Ti and at least one element selected from the group consisting of Al, Cr, Zr, Hf, B and Si on said substrate while irradiating said substrate with ion beams containing substantially nitrogen ions.

6. A sliding mechanism comprising a combination of a movable member and a static member, wherein either said movable member or said static member is made of a sliding member according to any of claims 1 to 4, or made by a method according to claim 5, and a remaining member is made of a material containing carbon.

7. A sliding mechanism according to claim 6, wherein said material containing carbon is a material containing substantially carbon, a material infiltrated with carbon or a thin film containing carbon.

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8. A sliding mechanism according to any of claims 1 to 4, a method according to claim 5 or a sliding mechanism according to claim 6 or 7, wherein said substrate is a metal material.

9. A dressing tool comprising a sliding member according to any of claims 1 to 4, or comprising a sliding member made by a method according to claim 5.

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference PEB187	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/JP 99/ 05838	International filing date *(day/month/year)* 22/10/1999	(Earliest) Priority Date *(day/month/year)* 23/10/1998
Applicant EBARA CORPORATION et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 5 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of Invention is lacking** (see Box II).

4. With regard to the **title,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

[ ] the text is approved as submitted by the applicant.

[X] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

[X] as suggested by the applicant.

[ ] because the applicant failed to suggest a figure.

[ ] because this figure better characterizes the invention.

[ ] None of the figures.

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Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

This invention relates to a hard coating developed for applications involving high-temperature corrosion by improving the performance of TiN coatings while retaining the superior wear resistance and low friction coefficient of TiN itself. The nitride-based sliding material has a face-centered cubic crystalline structure with lattice constant of between 0.414 and 0.423 nm, and is made of mostly TiN but contains at least one element selected from the group containing Al, Cr, Zr and Hf; or comprises a nitride-based material containing substantially titanium nitride and at least one element selected from a group consisting of B and Si, and having a face-centered cubic crystalline structure comprising crystallites of an average size of not more than 9 nm.

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Date of the actual completion of the international search	Date of mailing of the international search report
26 January 2000	02/02/2000

Name and mailing address of the ISA	Authorized officer
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X	VAZ F ET AL: "Physical, structural and mechanical characterization of Ti/sub 1-x/Si/sub x/N/sub y/ films" 25TH INTERNATIONAL CONFERENCE ON METALLURGICAL COATINGS AND THIN FILMS, SAN DIEGO, CA, USA, 27 APRIL-1 MAY 1998, vol. 108-109, no. 1-3, pages 236-240, XP000869552 Surface and Coatings Technology, 10 Oct. 1998, Elsevier, Switzerland ISSN: 0257-8972 table 1 ---	3,4
X	SUN X ET AL: "REACTIVELY SPUTTERED TI-SI-N FILMS 1. PHYSICAL PROPERTIES" JOURNAL OF APPLIED PHYSICS,US,AMERICAN INSTITUTE OF PHYSICS. NEW YORK, vol. 81, no. 2, 15 January 1997 (1997-01-15), page 656-663 XP000659450 ISSN: 0021-8979 paragraph '0003! ---	3
X	EP 0 166 349 A (SUMITOMO ELECTRIC INDUSTRIES) 2 January 1986 (1986-01-02) claims 1-4 ---	5
X	TAKANO I ET AL: "Formation of Ti-Al-N thin films by the dynamic ion mixing method" 9TH INTERNATIONAL CONFERENCE ON SURFACE MODIFICATION OF METALS BY ION BEAMS, SAN SEBASTIAN, SPAIN, 4-8 SEPT. 1995, vol. 84, no. 1-3, pages 409-413, XP000869550 Surface and Coatings Technology, Oct. 1996, Elsevier, Switzerland ISSN: 0257-8972 paragraph '0002!; figure 1 ---	5
Y	SHEW B -Y ET AL: "Effects of r.f. bias and nitrogen flow rates on the reactive sputtering of TiAlN films" THIN SOLID FILMS,CH,ELSEVIER-SEQUOIA S.A. LAUSANNE, vol. 293, no. 1-2, 1997, page 212-219 XP004080859 ISSN: 0040-6090 paragraph '03.3! --- -/--	2

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/JP 99/05838

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 014 (P-1672), 11 January 1994 (1994-01-11) & JP 05 250770 A (NISSIN ELECTRIC CO LTD), 28 September 1993 (1993-09-28) abstract	1-9
A	EP 0 685 439 A (EBARA CORP ;AGENCY IND SCIENCE TECHN (JP)) 6 December 1995 (1995-12-06) claims 1-3	6-9
A	US 5 731 079 A (EVANS JOSEPH D ET AL) 24 March 1998 (1998-03-24) column 3, line 12 - line 28	9

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/JP 99/05838

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0166349 A	02-01-1986	JP 1760725 C	20-05-1993
		JP 4004394 B	28-01-1992
		JP 61015967 A	24-01-1986
		AT 47431 T	15-11-1989
		CA 1240281 A	09-08-1988
		US 4634600 A	06-01-1987
JP 05250770 A	28-09-1993	NONE	
EP 0685439 A	06-12-1995	JP 8105447 A	23-04-1996
		JP 9068227 A	11-03-1997
		JP 9068228 A	11-03-1996
		US 5700546 A	23-12-1997
US 5731079 A	24-03-1998	US 5681653 A	28-10-1997

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PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
PEB187		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/JP99/05838	22/10/1999	23/10/1998
International Patent Classification (IPC) or national classification and IPC C23C14/06		
Applicant EBARA CORPORATION et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
28/02/2000	18.01.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Brisson, O Telephone No. +49 89 2399 8449

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/JP99/05838

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1-21	as originally filed				
Claims, No.:					
1-18	as received on	09/10/2000	with letter of	09/10/2000	
Drawings, sheets:					
1/5-5/5	as originally filed				

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   - ☐ the description, pages:
   - ☒ the claims, Nos.: 2, 4-9

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☐ the drawings, sheets:

5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)
   see separate sheet

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

   ☐ the entire international application.

   ☒ claims Nos. 15-17.

because:

   ☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

   ☐ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

   ☒ the claims, or said claims Nos. 15-17 are so inadequately supported by the description that no meaningful opinion could be formed.

   ☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination report cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

   ☐ the written form has not been furnished or does not comply with the standard.

   ☐ the computer readable form has not been furnished or does not comply with the standard.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

   Novelty (N) Yes: Claims 1, 3, 10-14, 18

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	No:	Claims	
Inventive step (IS)	Yes:	Claims	1, 3, 10-11, 13-14, 18
	No:	Claims	12
Industrial applicability (IA)	Yes:	Claims	1, 3, 10-14, 18
	No:	Claims	

2. Citations and explanations
see separate sheet

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Re Item I

Basis of the report

This report has been established as if amended claims 15-17 had not been filed, since the subject-matter of these claims is considered to go beyond the disclosure as filed (Rule 70.2(c) PCT). According to the disclosure page 5, lines 10-14 and page 8, lines 5-13, the preferred substrate is not defined as a metallic substrate in general, but as material having "a low coefficient of thermal expansion of not more than 11×10^{-6} so as to produce tight bonding".

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. relevant prior art

Reference is made to the following documents:

D1: MUENZ W -D: 'TITANIUM ALUMINIUM NITRIDE FILMS: A NEW ALTERNATIVE TO TIN COATINGS' JOURNAL OF VACUUM SCIENCE AND TECHNOLOGY: PART A,US,AMERICAN INSTITUTE OF PHYSICS. NEW YORK, vol. 4, no. 6, November 1986 (1986-11), page 2717-2725 XP002064735 ISSN: 0734-2101

D2: VAZ F ET AL: 'Physical, structural and mechanical characterization of Ti/sub 1-x/Si/sub x/N/sub y/ films' 25TH INTERNATIONAL CONFERENCE ON METALLURGICAL COATINGS AND THIN FILMS, SAN DIEGO, CA, USA, 27 APRIL-1 MAY 1998, vol. 108-109, no. 1-3, pages 236-240, XP000869552 Surface and Coatings Technology, 10 Oct. 1998, Elsevier, Switzerland ISSN: 0257-8972

D5: TAKANO I ET AL: 'Formation of Ti-Al-N thin films by the dynamic ion mixing method' 9TH INTERNATIONAL CONFERENCE ON SURFACE MODIFICATION OF METALS BY ION BEAMS, SAN SEBASTIAN, SPAIN, 4-8 SEPT. 1995, vol. 84, no. 1-3, pages 409-413, XP000869550 Surface and Coatings Technology, Oct. 1996, Elsevier, Switzerland ISSN: 0257-8972

D6: SHEW B -Y ET AL: 'Effects of r.f. bias and nitrogen flow rates on the reactive sputtering of TiAlN films' THIN SOLID FILMS,CH,ELSEVIER-SEQUOIA S.A. LAUSANNE, vol. 293, no. 1-2, 1997, page 212-219 XP004080859 ISSN: 0040-6090

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D7: PATENT ABSTRACTS OF JAPAN vol. 018, no. 014 (P-1672), 11 January 1994 (1994-01-11) & JP 05 250770 A (NISSIN ELECTRIC CO LTD), 28 September 1993 (1993-09-28)

D9: US-A-5 731 079 (EVANS JOSEPH D ET AL) 24 March 1998 (1998-03-24)

2. Process claims 12

2.1. The subject-matter of independant claim 12 differs from the teaching of document D1 (see I. Introduction, lines 5-8), D5 (see figure 1), D6 (see I. Introduction, lines 9-11) in that the element deposited with Ti is not Al but one from the group consisting of Cr, Zr, Hf and B. In D7 (see abstract) B is deposited with Ti but the substrate coated is a magnetic recorder head which is obviously not suitable as a substrate for a cutting tool. D9 discloses a process where Ti and Zr are deposited from a cathodic arc in a vacuum chamber having a controlled pressure of N (see column 2, lines 8-11). Such a process does not involve an ion beam as claimed in claim 12. Therefore, the subject-matter of amended claim 12 is considered to be new in the sense of article 33(2) PCT.

2.2. The use of a dynamic ion beam mixing (DM) film deposition process for deposition of TiBN having enhanced hardness and abrasion resistance is known from D7 (see abstract). The process for coating a metallic substrate suitable for making a sliding member seems to be identical to the process for coating a magnetic recording head as in D7 apart from the nature of the substrate to be coated. It would be obvious to the person skilled in the art, namely when the same result is to be achieved, ie hard coating with high abrasion resistance, to apply the process of D7 with corresponding effect to a substrate suitable for making a sliding member as claimed in claim 12. The subject-matter of claim 12 does therefore not involve an inventive step (Article 33(3) PCT).

3. Product claims 1, 3, 10, 11, 13, 14, 18

3.1. Independant claim 1

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and discloses the coating of parts of cutting tools, ie "sliding members", with TiAl-nitride compound. The crystal structure of the coating is the face-centred cubic structure of TiN, the lattice parameter being shrunk to 4.20Å in the case of Ti/Al=1 (see page 2720). Therefore, the subject-matter of independant claim 1 can only be clearly distinguished from the teaching of D1 in that the coating comprises Cr instead of Al. Therefore, the subject-matter of claim 1 is considered to be novel in the sense of Article

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33(2) PCT.
None of the prior art cited in the search report mentions or suggests a sliding member comprising a TiCrN hard coating. Therefore, the subject-matter of claim 1 is also considered to involve an inventive step in the sense of Article 33(3) PCT.

3.2. Independant claim 3
The document D2 (see table 1 and Conclusions) is regarded as being the closest prior art to the subject-matter of claim 3, and discloses the coating of cutting tool parts, ie "sliding members", with TiSi-nitride compounds instead of TiB-nitride compounds as claimed in claim 3. Therefore, claim 3 is considered to be novel in the sense of Article 33(2) PCT.
None of the prior art cited in the search report mentions or suggests a sliding member comprising a TiBN hard coating. Therefore, the subject-matter of claim 3 is also considered to involve an inventive step in the sense of Article 33(3) PCT.

4. Independant claim 10 and claim 11
A sliding member comprising a hard coating made of a nitride-based material containing layers of TiN and ZrN is known from D9 (see column 3, lines 12-28). However, TiN and ZrN lattice parameters are above the range claimed. On the other hand, document D6 (see §1. Introduction) mainly dealing with TiAlN coating for cutting tools, mentions TiZrN films in a non limited list of multicomponent films. No references to its hardness, its abrasion resistance or a possible use of this specific composition in the field of cutting tools are given. Therefore, the subject-matter of claim 10 is considered to be novel.
Moreover, none of the documents cited in the search report mentions or suggests a sliding member comprising a coating made of TiN and Zr and/or Hf with a lattice constant in the range claimed. The subject-matter of independant claim 10, as well as claim 11 dependant to claims 1, 3 and 10 is also therefore considered to involve an inventive step in the sense of Article 33(3) PCT.

5. Claims 13, 14 and 18
Claims 13, 14 and 18 deals with cutting tools comprising a sliding member according to any of claims 1, 3 and 10. Since such a sliding member is considered as novel and involving an inventive step, the sliding mechanism of claim 13-14 and the dressing tool of claim 18 are also considered to fulfill the requirements of Article 33(2) and (3) PCT.

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